Assessment of Bambara Groundnut (*Vigna Subterranea* (L) Verdc) Varieties for Adaptation to Rainforest Agro-Ecological Zone of Anambra State of Nigeria

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ABSTRACT

Field experiments were carried out to evaluate the adaptability of Bambara groundnut *(Vigna subterranea (L) Verdc) varieties to rainforest* agro-ecological zone of Anambra State using selected varieties. The varieties used were: EXMF1, EXMF2, EXMF3, EXMF4, IITA355, IITA182, IITA165, IITA1480, IITA1132, ENZK1 and ENZK2. The aim of this experiment was to identify the varieties of Bambara groundnut that will be most suitable in this agro-ecological zone. The design used in this experiment was a Randomized Complete Block Design (RCBD) replicated three times. The parameters collected were: days to seed germination (seed emergence), percentage seed germination, number of leaves, total leaf area, number of pods per plant, pod and seed weight per plant(g), and seed yield (kg/ha). The result showed that varieties EXMF1, EXMF4, IITA165 and ENZK2 performed better than others both in growth and yield parameters collected and analyzed. Variety EXMF4 was outstanding in yield with the mean value of 5267kg/ha followed by ENZK2 with the mean value of 5000kg/ha. The least in yield was IITA182 followed by ENZK1 with the values of 2445 and 2600kg/ha respectively. The outstanding variety EXMF4 was recommended to farmers in the area for cultivation.

Keywords: *Bambara groundnut, varieties, Adaptation, Evaluation, Agro-ecological zone.*

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Highlights of this paper

- This study is one of very few studies which have investigated into Bambara groundnut adaptation to rainforest zone of Anambra State.
- The paper's primary contribution is affirmation that generally, Bamabra groundnut can grow and yield well in the area of study and that varieties EXMF1, EXMF4, IITA165 and ENZK2 were outstanding in yield.

1. INTRODUCTION

Bambara groundnut *(Vigna subterranea*) is one of the important but neglected and underutilized annual leguminous crops in Africa. The entire plant is similar to the common peanut, but a low, fat annual with compound leaves of three leaflets [1]. The pods are formed and ripen underground much like the peanut [2] with one or two seeds in it. It was seen as poor man's crop years back after the introduction of peanut. It has potentials to improve nutrition even help in rural development. As a legume, it is capable of fixing atmospheric nitrogen to the soil for the benefit of other plants. Bambara groundnut has an ability to resist pest and diseases to certain extent and can thrive in poor soils where other crops such as maize and yam fail. Bambara groundnut consists of two botanical forms: var *spontanea*, comprising the wild forms restricted to Cameroon, and var: *subterrenea*, comprising the cultivated forms found predominantly in sub-Saharan Africa [3]. Bambara groundnut is a crop, which is adapted to a wide range of environmental conditions that may not favour other arable crops. Bambara groundnut is used for both human and animal consumption with some other economic importance as green manure. In Africa, the seeds are also used in traditional medicine, in that water from the boiled maize and pulse mixture is drunk to treat diarrhea; the leaves are pounded with those of *Lantana trifolia (*L.), then water is added and the solution used to wash livestock as a preventive against ticks and this solution is also used as a pesticide on vegetable [4].

Bambara groundnut was found to be intercropped with some other arable crops such as cereals (maize, guinea corn), tubers (cassava, yam) etc through traditional farming systems. The seeds command a high market price with demand far out weighing supply in many areas [5]. It constitutes a balance ration and complete food to the people that consume it as a meal or when combined with some cereal based food. It is one of the most important drought resistant grain legumes. The crop has a potential for higher yield and conducting crop researches on the crop for improvement could raise data that could make it measure with other world known edible legumes. Bambara groundnut is consumed much with little or no cultivation in the South East of Nigeria. Animal protein is very expensive and not affordable to an average Nigerian. More so, people have subjected themselves to the affordable class of food (starch food) which easily affect health of many individuals, hence the need of this study with the aim of evaluating some Bambara groundnut varieties for their adaptation in the rain forest agro-ecological zone.

2. MATERIALS AND METHODS

2.1. Study Area

The experiment was carried out in rain forest zone of Ogbakuba in Ogbaru Local Government Area of Anambra State, Nigeria. The study was conducted during cropping seasons at the Practical Farm of Ogbaru High School, Ogbakuba. Ogbaru Local Government Area is located in the south western part of Anambra State and lies between latitude 5°42' and 6°08'N and Longitudes 6°42' and 6°50'E. The climate is hot wet equatorial with average maximum temperature of 30°C and the average minimum of 24°C depending on the season of the year. Rainfall is experienced for 7 months of the year; with a total annual value of about 1,900mm [6].

2.2. Experimental Materials and Methods

Twelve varieties of Bambara groundnut were used. Six varieties were obtained from IITA Ibadan, four from Makarfi - Zaria and two from Enugu - Ezike in Enugu State (as local). The twelve varieties were named as follows: EXMF1, EXMF2, EXMF3 and EXMF4 (from Makarfi-Zaria); ENZK1 and ENZK2 (from Enugu-Ezike in Enugu State). Varieties from International Institute for Tropical Agriculture Ibadan were: IITA355, IITA182, IITA165, IITA1480, IITA1132 and IITA1213.The experiment was on Randomized Complete Block Design replicated three times. The experimental site was cleared manually with machetes' and hoes. The representative soil samples were collected with a tubular sampling auger in varied places within the place. These samples were bulked and composited for the analysis of the physico - chemical parameters of the soils for the research. The samples were analyzed at the Soil Science Laboratory of University of Nigeria Nsukka following the standard routine procedures. The debris was gathered, bundled out and the site measured, marked and divided into three portions (blocks) as replicates. On the whole, there were thirty-six plots in each year each plot measured 2 m x 2 m separated by 0.5m apart between plots and 1m apart between blocks replicated three times. The marked out plots were filled and made into beds using hoe. The seeds were sown at a depth of 5cm in each plot across the locations at the rate of one seed per hole, with spacing of 30 x 20cm. the plants were weeded and spray-monitored with insecticide at appropriate time during the experimental periods.

2.3. Data Collection

Data were collected from the thirty randomly selected plants in the middle from each plot. During each period of data collection, five different plants were uprooted for data collection. On the development, seed emergence was taken by counting number of days it took each variety to emerge after sowing and percentage (%) seed germination was taken by counting number of plants that germinated per variety in each season (year) at fourteen days after sowing. On growth parameters, number of leaves and total leaf area at 4, 8, 12 and 16 weeks after sowing were measured from five randomly selected plants within the sampled middle rows. Number of leaves per plant was counted and leaf area (cm^2) per plant was measured by multiplying length and width of three leaves (small, medium and large) from the sampled plants and calculated with an equation. Thus: ALA "0.71 ELA+0.23 [7]. Where ALA is actual leaf area, then ELA = length x width of the leaflets. Collections were made at 4, 8, 12 and 16WAS and the (average calculated and recorded. On yields, number of pods per plant, pod and seeds weight, (g) per 'plant and seed yield kg/ha were collected.

2.4. Data Analysis

Data collected were subjected to Analysis of Variance (ANOVA) and treatment means were separated using Duncan Multiple Range Test (DMRT) SAS [8].

3. RESULTS AND DISCUSSION

3.1. Effects of Variety and Year and Their Interactions on Germination Parameters of Bambara Groundnut

The result of effects of year and variety on days to first germination and percentage germination is shown in Table 1. Available data showed that there were no significant differences among the Bambara groundnut planted at Ogbakuba in 2011 and 2012 cropping seasons, though the seeds of Bambara groundnut sown at Ogbakuba in 2012 emerged first with mean value of 6.44 days. This showed that the varieties used had thinner seed coat that enabled the varieties emerge at the same period between 6-7 days. This is in consonant with the findings of Akpalu [9] who

reported that the mottled cream colour variety with thinner seed coat emerged 7 days after sowing while others emerged between 12 and 14 days after sowing due to the thickness of the seed coat.

Table-1. Effects of variety and year and their interactions on germination parameters of Bambara groundnut.

Location/Year/ Variety	Days to 1st Germination		Mean	Germination Percentage		% Mean
	2011	2012		2011	2012	
Ogbakuba (Loc 1) Variety						
EXMF1	6.00^{d}	6.00^{c}	6.00^{d}	95.0^{ab}	72.7^{ac}	83.9^{a}
EXMF2	6.00^{d}	6.00^{c}	6.00^{d}	81.0^{cd}	67.7^{ac}	74.4^{b}
EXMF3	6.00^{d}	6.33^{bc}	6.18^{cd}	85.0^{cd}	59.3^{bd}	70.2^{bc}
EXMF4	6.00^{d}	6.00^{c}	6.00^{d}	81.0^{cd}	74.3^{ab}	79.7^{ab}
IITA355	7.00^{ab}	7.00^{ab}	7.00^{a}	97.0^{a}	79.3^{a}	88.2^{a}
IITA182	6.63^{bc}	7.00^{ab}	6.84^{bc}	57.7^{ef}	35.0^{e}	46.4^{d}
IITA165	6.00^{d}	6.00^{c}	6.00^{d}	82.7^{cd}	67.7^{ac}	75.2^{b}
IITA1480	6.67^{bc}	6.33^{bc}	6.68^{bc}	91.7^{ac}	58.0^{bc}	74.9^{b}
IITA1132	6.67^{bc}	6.33^{bc}	6.67^{bc}	50.0^{ef}	58.7^{bc}	54.4^{cd}
IITA1213	7.00^{ab}	7.33^{a}	7.00^{a}	85.0^{cd}	58.0^{bd}	71.5^{bd}
ENZK1	6.33^{cd}	6.33^{bc}	6.33^{cd}	66.7^{de}	74.3^{ab}	70.5^{bc}
ENZK2	7.33^{a}	6.67^{ac}	7.00^{a}	76.3^{de}	30.3^{de}	58.3^{c}
Yrs	NS	NS	NS	*	*	*
Var	*	NS	*	*	*	*
Yr x Var	NS	NS	NS	*	*	*

Legend ** and * = highly significantly different and significantly different at P<0.01 and P<0.05 level of probability respectively, NS = not significant; Yr = year, Loc = location, Var = variety. Means with the same letter(s) under the same column and heading are not significantly different at P>0.05 using Duncan Multiple Range Test (DMRT).

On percentage germination, Bambara groundnut seeds sown in 2011 had the highest percentage germination with the mean values ranging from 50.0 - 97.0% and were significantly (P<0.05) better in germination percentage than those seeds sown in 2012 that ranges from 30.3 – 79.3% Table 1. This may be linked to environmental and soil effects associated with the period of planting which might have affected the seeds sown in 2012. This agreed with the findings of Stephen [10] who planted in two seasons (major and minor) and recorded that major season favored Bambara groundnut germination more than the minor season. Also Waele and Swanevelder [11] earlier reported that seed mergence and germination are affected by soil moisture and temperature. x respectively and were significantly (P<0.05) different from other varieties.

3.2. Effects of Variety on Number of Leaves and Total Leaf Area (Cm^2) on Bambara Groundnut at Different Sampling Periods

Table 2 showed the result of effect of varieties on number of leaves and total leaf areas of Bambara groundnut. Significant differences existed between the varieties investigated (P<0.05). The same varieties EXMF1, EXMF4, IITA355, IITA165 and ENZK2 had more number of leaves and total leaf area almost across the sampling periods. Variety EXMF3 had the least total leaf area at 12 and 16WAS with the mean values of 453.8 and 1117.9 respectively.

The differences observed in the number of leaves and total leaf area of Bambara groundnut may be attributed to differences in growth characters which were being influenced by genetic make-up of the plants. This is consistent with the findings of Adetiloye and Salau [12] and Sajjan, et al. [13] who reported that growth characters of crops varied because of differences in their genetic make-up. Also high number of leaf and large total leaf areas of Bambara groundnut found in this work could be attributed to the differences in leaf arrangement and photo synthetic activity in chlorophyll content.

Table-2. Effects of variety on number of leaves and total leaf area (cm^2) on Bambara groundnut at different sampling periods.

	Weeks after sowing							
	4	8	12	16	4	8	12	16
Variety	⟵			⟶	⟵			⟶
EXMF1	24.7^{ab}	90.2^{ac}	125.7^{ad}	224.2^{ab}	183.6^{ac}	825.9^{b}	1156^{ab}	1835.1^{ce}
EXMF2	18.3^{b}	85.8^{bd}	98.3^{cd}	105.8^{de}	124.9^{de}	539.7^{b}	585.6^{bc}	1457.3^{e}
EXMF3	21.8^{b}	75.2^{cd}	88.2^{d}	114.8^{de}	179.2^{bc}	562.8^{b}	453.8^{cd}	1117.9^{de}
EXMF4	25.7^{ab}	99.7^{ab}	132.5^{ac}	218.0^{ab}	231.7^{ab}	831.6^{b}	1138^{ab}	2337^{a}
IITA355	23.2^{b}	78.5^{cd}	93.7^{cd}	124.4^{bc}	180.3^{bc}	802.9^{b}	716.5^{bc}	1140.5^{be}
IITA182	21.3^{b}	76.5^{cd}	93.5^{cd}	106.2^{de}	169.2^{ce}	601.6^{b}	402.6^{b}	1533.9^{e}
IITA165	25.0^{ab}	109.8^{a}	125.2^{ad}	218.2^{ab}	170.9^{bd}	916.4^{b}	1223^{ab}	1855.5^{be}
IITA1480	22.5^{ab}	78.5^{cd}	108.0^{ad}	158.3^{bc}	174.0^{bd}	587.1^{b}	720.6^{bc}	1429.6^{e}
IITA1132	23.8^{b}	88.8^{ac}	113.5^{ad}	163.8^{bc}	176.8^{bd}	642.4^{b}	798.0^{bc}	1450.6^{e}
IITA1213	20.2^{b}	62.7^{d}	106.8^{ad}	117.0^{de}	143.8^{de}	509.9^{b}	467.8^{bc}	1728.9^{de}
ENZK1	18.7^{b}	88.7^{ac}	105.5^{ad}	204.7^{b}	167.5^{ce}	715.7^{b}	961.3^{ac}	1652.3^{de}
ENZK2	117.7^{a}	128.2^{a}	146.2^{a}	247.0^{a}	561.1^{a}	1113.5^{a}	1808^{a}	2444^{a}

Means with the same letter(s) under the same column and heading are not significantly different at P>0.05 using Duncan Multiple Range Test (DMRT).

3.3. Effects of Variety on the Yield and Yield Related Components of Bambara Groundnut

On yield in Table 3 there was gradual increase in number of pods per plant among the varieties used. At all the sampling periods, variety EMXF4 had the highest number of pods, pod and seed weight and seed yield kg/ha with the mean values of 50.0 (pod number), 36.0 (pod weight), 30.5 (seed weight) and 5367 kg/ha (seed yield). This was followed by three other varieties (ENZK2, IITA165 and ENZK1). These four varieties were outstanding in their yield and were significantly different (P<0.05) from other varieties. The variety with the least number of seeds per plant, pod weight and seed weight was IITA355 with the mean number of 16.2 pods per plant, 11.7 mean weight of pods per plant, while IITA182 was least in seed weight per plant and seed yield per hectare with the mean values of 08.7 and 2545 kg/ha .and were significantly lower than the rest of the assessed varieties.

Table-3. Effects of variety on the yield and yield related components of bambara groundnut.

Treament	Pod/plt (g)	Pod wt/plt (g)	Seed wt/plt (g)	Yield/ha (kg)
EXMF1	45.2^{ab}	33.3^{ab}	24.2^{ab}	4540^{ac}
EXMF2	25.2^{cd}	14.7^{bc}	10.8^{bc}	3323^{bd}
EXMF3	26.8^{cd}	23.7^{c}	20.0^{ab}	3245^{cd}
EXMF4	50.0^{a}	36.0^{a}	30.5^{a}	5367^{a}
IITA355	16.2^{d}	11.7^{b}	10.0^{bc}	2845^{cd}
IITA182	19.8^{cd}	12.8^{c}	08.7^{bd}	2545^{cd}
IITA165	46.5^{ab}	33.8^{a}	26.7^{ab}	4834^{ab}
IITA1480	30.0^{bd}	21.5^{c}	15.0^{bc}	3356^{bd}
IITA1132	25.7^{dd}	16.0^{b}	09.3^{bd}	3289^{bd}
IITA1213	27.5^{cd}	19.3^{c}	11.8^{bc}	2756^{bd}
ENZK1	31.5^{bc}	17.7^{c}	11.3^{bc}	3500^{d}
ENZK2	47.2^{ab}	35.0^{a}	26.9^{ab}	5200^{a}

Means with the same letter(s) under the same column and heading are not significantly different at P>0.05 using Duncan Multiple Range Test (DMRT).

The superiority of these four varieties (EXMF4, ENZK2, IITA165 and EXMF1) over others could be attributed to the ability of these varieties to partition the dry matter into pod filling (sink) at their own pace. This agrees; with the work of Stephen [10] who attributed differences among the number of pods per plant to varieties respond to diverse environmental conditions. Ibrahim [14] and Ibraheem [15] had similar report on number of pods per plant.

4. CONCLUSION

From the results obtained in this study, it could be concluded that out of the twelve varieties of Bambara groundnut evaluated, only four varieties (EXMF4, EXMF1, 1ITA165 and ENZK2) performed well both in growth and

in yield parameters. Also variety ENZK1 grew well but the growth was not at par with the yield which is the ultimate. Variety EXMF4 showed superiority over others especially in yield and could be grown in the area.

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